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TECHNICAL EFFICIENCY, MARKET SHARE AND PROFITABILITY OF MANUFACTURING FIRMS IN CÔTE D'IVOIRE

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Abstract

This paper measures the level of technical efficiency of manufacturing firms in Côte d'Ivoire using a stochastic frontier production function and analyses its effect on firm market shares and profitability. Most sectors of activity exhibit large economies of scale implying that one source of efficiency gain consists of broadening the scale of activities of firms. Moreover, irrespective of size, a large majority of firms is producing far below its maximum attainable output level but some significant inter-firm differences seem to exist. Foreign owned firms and formal firms tend to be more efficient. More efficient production and more advertising intensive marketing translate into a better competitive position and via its impact on the market share into higher profitability. However, besides the competitive market selection mechanism, legitimation and reputation effects are also important as determinants for a firm's competitive position and profitability.

Keywords: technical efficiency, stochastic frontier production function, profitability

JEL Codes: D24, L6, O55

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Introduction

Raising efficiency of manufacturing firms in developing countries has become an essential condition for further industrial development. This is especially true for African firms, which are found to exhibit relatively low levels of efficiency. Since the beginning of the 1980s Structural Adjustment Programmes are implemented in order to introduce market discipline which stimulates efficiency. Previous research on the development of manufacturing firms in Sub-Saharan Africa has also shown that firms grow mainly through internal financing of activities, as markets for credit and capital are characterised by severe information asymmetries and imperfections. Credit and infrastructure constraints are widely recognised to be among the most severe growth hampering factors. It is therefore essential that firms reach levels of efficiency and profitability which allow them to finance further expansion of activities with internal financial resources.

The aim of this paper is to uncover to what extent market selection works in rewarding more efficient firms with a larger market share and higher profitability. The data used for the analysis are cross section data covering a heterogeneous sample of manufacturing firms in Côte d'Ivoire. The data were gathered in the framework of the World Bank project RPED ('Regional Program on Enterprise Development in Africa) executed in Côte d'Ivoire in 1995 and 1996.

The first part of the paper analyses technical efficiency of manufacturing firms in Côte d'Ivoire. Individual firm efficiency scores are estimated using a stochastic frontier production function and it is analysed whether there are systematic efficiency differences among heterogeneous groups of firms. The first section describes the methodology used by the stochastic frontier production function models for cross-section data. The assumptions and specifications used in this paper are explicited in section 2. In section 3 the potential sources of efficiency differences are discussed. The data are briefly presented in section 4, while section 5 shows the estimation results.

In a second part of the paper it is investigated to what extent firm efficiency translates into superior performance in terms of market share and profitability when other determinants which interact in the market selection process are included in the analysis. In a related paper (Sleuwaegen, Goedhuys, 1997) it was found that in developing economies legitimation and reputation of firms in the industry interacts in the selection process and determines the growth opportunities of firms. Section 6 therefore analyses to what extent these effects, besides efficiency, determine firm market shares and profitability. Section 7 concludes.

1. Estimating technical efficiency

Technically efficient production is defined as the maximum quantity of output attainable from given inputs. Technical efficiency is measured at the level of the industry, where the performance of individual firms are compared and the best performing firms determine the frontier production possibility set. Deviations from this maximum output level imply that firms are technically inefficient.

Prior to any efficiency computation, a production possibility frontier has to be estimated. The production frontier can be estimated using two main alternative methodologies: the deterministic frontier models and the stochastic frontier approach. The deterministic frontier models, including the widely applied technique of Data Envelopment Analysis (DEA), essentially 'envelopes' the data 'from above', i.e. it wraps a convex hull around the observed production points. The methodology is non-parametric. No assumptions are required about the form of the technology. An important drawback of deterministic frontier models in general is, that it assumes that all deviations of an observation from the theoretical maximum are attributable to technical inefficiency. Consequently, a fundamental problem with these models is that any measurement error as well as any other source of stochastic variation in the dependent variable must be interpreted as reflecting technical inefficiency. Hence, outliers can have a dramatic upward shifting effect and lower the estimated technical efficiency measures sensibly.

Stochastic frontier methodologies are parametric and entail assumptions about specific functional forms of the production frontier. Estimation of the frontier production function is assumed to be influenced by technological conditions as well as by random external factors such as equipment failures, bad weather, or unexpected disturbances in related markets. Hence, uncontrollable events, measurement errors and noise in the data are taken into account. The production frontier in itself is considered to be stochastic and located with a certain probability on the estimated level. The observations may thus lie below or even above the frontier, depending on a collection of stochastic elements outside the control of the producer. In view of the possibility of noise in the data, the stochastic frontier methodology is preferred for the analysis of efficiency differences among firms.

The stochastic frontier relationship for firm i can be expressed as :

$$y_i = f(x_i, \beta) exp(\varepsilon_i) \qquad (1)$$

where y_i is a single output, x_i a vector of inputs, β a vector of corresponding parameters and ε_i the error term which captures the deviation of firm i from the frontier and which is composed of two terms:

$$\varepsilon_i = v_i - u_i, \quad \text{with } u_i \geq 0. \qquad (2)$$

The component v_i is the conventional symmetric error term representing random factors. It follows a normal distribution with zero mean and variance σ_v^2. The component u_i, in contrast, is a non-negative one-sided error term capturing technical efficiency, given by the ratio of observed output to frontier output, i.e.,

$$TE_i = \frac{y_i}{f(x_i \beta)\exp(v_i)} = \exp(-u_i) \qquad (3)$$

where $0<TE(y_i, x_i)<1$. TE_i is also the conventional measure of total factor productivity. Since only the composite error (ε_i) is observed, the estimation of u_i, the individual firm efficiency score, has to be obtained indirectly, by making additional assumptions about its specific distribution.

2. Assumptions and model specifications

Basic model

For the estimation of the production frontier a general Cobb-Douglas function is used:

$$Y_i = AK_i^{\alpha} L_i^{\beta} e^{(v_i - u_i)} \tag{4}$$

where Y_i measures value added in enterprise i, L_i represents labour input and K_i denotes the capital stock. Rewriting this function in log-linear terms results in :

$$\ln Y_i = \ln A + \sum_{j=1}^{n-1} \delta_j D_{ij} + \sum_{j=1}^{n} \alpha_j D_{ij} \ln K_i + \sum_{j=1}^{n} \beta_j D_{ij} L_i + v_i - u_i \tag{5}$$

where D_{ij} are sectoral dummy variables to allow for different technologies in different sectors. It is assumed that the one-sided error term capturing inefficiency, u_i, follows an exponential distribution, satisfying the condition $u_i > 0$ for a firm whose output lies below the frontier. Then following Jondrow et. al. (1982), firm-specific efficiency for each observation in the sample is given by the mean of the inefficiency error (u_i) conditioned on the total error (v_i - u_i). Thus,

$$E[u|\varepsilon] = z + \sigma_v f(z/\sigma_v) / F(z/\sigma_v) \tag{6}$$

where E is the expectation operator, $z = \varepsilon - \theta\sigma_v^2$ and f(.) and F(.) are the density and the cumulative distribution functions respectively. This yields unbiased point estimates of an efficiency parameter for firm i as:[1]

$$\hat{TE}_i = \exp[-\hat{u}_i] \tag{7}$$

In terms of the *average* technical efficiency of the sample, an estimate is given by $1/\theta$. The proportion of the total variance attributable to variance of the residuals measuring technical inefficiency is given by

$$\frac{\sigma_u^2}{\sigma_\varepsilon^2} = \frac{\frac{1}{\theta^2}}{\frac{1}{\theta^2} + \sigma_v^2} \tag{8}$$

A more natural estimate of average technical efficiency is suggested by Battese and Coelli (1988) and calculated as the unconditional mean of TE_i, i.e., $E[\hat{TE}_i]$.

Firm specific inefficiency model

Central to the analysis of technical efficiency is the question whether there are systematic efficiency differences among heterogeneous groups of firms. Using cross section data, systematic inter firm efficiency differences can be measured following different approaches.

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1 The estimates are unbiased but inconsistent because their variance remains non-zero regardless of sample size, (Jondrow and others, 1982).

A first approach consists basically in estimating the technical efficiency score for the individual firms following one of the proposed frontier or average production function methodologies, and to regress the technical efficiency score on a set of relevant firm characteristics using OLS. This approach has two important drawbacks. First, if technical inefficiency is related to firm characteristics, omission of these characteristics in the frontier estimation results in a bias of the parameter estimates of the frontier production function. Second, an inconsistency about the distribution of u arises if it is assumed to follow a one-sided distribution such as the exponential, gamma or truncated normal distribution in the estimation of the frontier production function, while OLS regression of the inefficiency index TE=exp(-u) assumes the index to follow a normal distribution.

Another approach, the one followed in this paper and first applied by Pitt and Lee (1981), consists of adding firm characteristics as extra regressors to the estimating frontier production function. Following Reifschneider and Stevenson (1991), the inefficiency term u_i is a function of systematic influences related to firm characteristics and one random factor:

$$u_i = g(Z_i, \gamma) + w_i$$

where Z_i is a vector of firm specific inefficiency explanatory variables, γ are the corresponding coefficients and w_i is the unexplained component of inefficiency.

It is assumed that the firm characteristics shift the frontier production function.

$$u_i = \sum_{k=1}^{m} \gamma_k Z_{ik} + w_i$$

The unexplained inefficiency component w_i follows the same distribution as u_i, in this case the exponential distribution. The Cobb-Douglas specification of the frontier production function becomes:

$$Y_i = AK_i^{\alpha} L_i^{\beta} e^{-\gamma Z_i} e^{(v_i - w_i)} \tag{9}$$

which, in log-linear terms and after inclusion of sectoral dummies, is expressed by the following equation :

$$\ln Y_i = \ln A + \sum_{j=1}^{n-1} \partial_j D_{ij} + \sum_{j=1}^{n} \alpha_j D_{ij} \ln K_i + \sum_{j=1}^{n} \beta_j D_{ij} L_i - \sum_{k=1}^{m} \gamma_k Z_{ik} + v_i - w_i \tag{10}$$

This expression furthermore assumes that the effect of firm attributes on efficiency is sector independent. A drawback of this methodology is that multicollinearity problems are likely to arise to the extent input levels are correlated with firm attributes[2].

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[2] Ideally with the use of panel data other techniques become available which permit to regress estimates of firm fixed effects on firm characteristics, thereby avoiding the problems related to the two proposed estimation methods for cross section data, i.e. omitted variable bias and multicollinearity.

3. Firm heterogeneity and firm efficiency

Given the large heterogeneity firms tend to exhibit in developing countries and the different competitive regimes firms are exposed to, it is crucial to analyse the effect of firm characteristics in order to unravel potential sources of inefficiency. A first set of factors which could be expected to affect firm efficiency is related to the age of the firm. As suggested by passive learning models of competitive selection (Yovanovic, 1982), firms learn about their own efficiency level over time and adjust their scale of operations accordingly, with inefficient firms exiting and more efficient firms growing into a larger size. This passive learning model implies systematic efficiency differences among firms, in that larger firms are more efficient, given firm age. Moreover, as the process of development and effective deployment of technology is an active learning process, older firms might have increased their efficiency level more successfully over time and might have been able to organise production so as to reduce X-inefficiency.

The positive relationship between firm age and efficiency may, however, be weakened by a dynamic process of creative destruction, in which younger firms enter with upgraded and more innovative technology while older firms have invested in the past in durable equipment and may lag behind newer and superior technology. Therefore, entrants increase industry wide efficiency and younger firms may reach higher levels of efficiency while sunk costs impede older firms to shift towards more efficient technology.

A second effect on efficiency may originate from the ownership structure of firms. Foreign linkages through ownership can facilitate the flow of knowledge and technical progress into firms from outside the country. In addition to direct technology transfer through licensing and technical assistance firms can acquire technical expertise in the process of foreign direct investment. The effect of foreign ownership on firm efficiency has been subject of several empirical studies, most of which finding a positive relationship between foreign ownership and technical efficiency (Pitt and Lee, 1981). Foreign investment has played an important role in the industrial sector of Côte d'Ivoire, a result of former open door policies aimed at attracting FDI and a historically liberal attitude towards immigration. Over the period 1980-91, foreign ownership represented on average 78% of private sector equity[3]. Foreign firms are mostly French and Lebanese owned.

A third factor, related to the institutional environment of the firm, is the formal status of the firm. In a previous study (Sleuwaegen and Goedhuys, 1997) it was shown that, when markets are characterised by high transaction costs, as is the case in many developing countries, the degree of legitimation, i.e. the degree to which the firm is socially recognised and accepted in the business environment, facilitates a firm's access to scarce resources, such as credit, foreign exchange, imported spare parts, licences or skilled labour and so forth, necessary for efficient production. Formal registration by the firm captures the effects of legitimation fairly well. Formality was found to increase sensibly a firm's growth opportunities (Sleuwaegen and Goedhuys, 1997). Due to better access and combination of resources, the production frontier might be expected to lie on a higher level for formal firms than for informal ones. However, absence of this effect would imply that legitimation as

[3] This percentage of foreign ownership is estimated on the sample of firms which submit their records yearly with the 'Banque de Données Financières'.

alternative resource allocation mechanism to competition, does not channel resources to the most efficient firms in the industry, thereby perpetuating existing market failures.

4. Data and variables

The data used for the analysis were gathered in the framework of the World Bank project 'Regional Program on Enterprise Development (RPED)' executed in Côte d'Ivoire in 1995 and in 1996. Survey data were collected through intensive interviews for a representative and heterogeneous sample of large and small manufacturing firms active in one of the four main manufacturing sectors: food processing, textiles, wood working and metal working. The firms are of different age classes and ownership structure and they belong to both the formal[4] and the informal sector. Most firms are located in Abidjan, the main economic centre of the country. A smaller number of firms is located in the urban regions of San Pedro and Bouaké. The data used for the estimation are for the year 1994.

Output is measured by value added, calculated as total value of output minus the cost of raw materials and indirect costs. Labour input is measured by the total number of employees working in the firm, including part time and seasonal workers weighted for their effective labour performance. The firms' capital stock is measured as replacement value or sales value of equipment. If only the historical value of equipment was available, these data were used instead, after correcting for inflation[5] and depreciation[6]. Such estimate of the capital stock is available for 92 manufacturing firms. In order to use a larger number of observations, for those firms where capital stock could not be estimated directly from the value of equipment, the capital stock could be estimated using data on indirect costs related to equipment[7]. Using this approach, a larger sample of 175 firms was available for the analysis.

The sector dummy variables included in the estimating equation relate to agro-industries (SECFOOD), wood working (SECWOOD) and metal working (SECMETL), the reference sector being firms in the textiles sector.

For the estimation of the firm specific inefficiency model the effect of firm age on firm efficiency is captured by a binary variable AGE which equals one for firms of over 5 years of

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[4] Firms are defined as 'formal' if they are registered, submit records yearly with the 'Banque de Données Financières' (BDF), fulfil all tax obligations including VAT, company taxes and business license taxes at local and national level, and respect labour and other regulations. Informal firms pay at most local business license tax ('*patente*'). Semi-formal firms don't keep full records but nevertheless pay some taxes on turnover.

[5] An appropriate capital stock deflator was constructed from the national accounts, from a comparison of gross domestic fixed investment at current prices and at constant prices (Source: World Tables,1995, World Bank).

[6] The depreciation rate was taken to be 15%. This rate is close to the depreciation rate which could be calculated for firms who provided data on both the historical value and on the replacement value of their capital stock. A regression analysis estimated the depreciation rate to be 16% yearly.

[7] The cost of electricity, water and fuel was found to be highly correlated with the capital stock for those firms which provided both sets of data. The relation between the logarithm of the capital stock (CS) and the logarithm of indirect costs (IC) was estimated in a regression analysis: $CS = 4.01 + 0.82\ IC$; $R^2=0.739$; $F(1,88)=253.4$.

age. To account for the effect of foreign ownership on firm efficiency two binary variables are added, EUROPEAN and ASIAN, if majority of the equity capital is European respectively Asian owned, the reference group being African owned firms. In order to take further account of the firm's legitimation in the industry, a binary variable FORMAL is included. The variable takes the value one for the formal firms, which are officially registered, fulfil all legal and tax obligation and takes the value zero for informal firms, including the so-called semi-formal firms.
Table 1 shows the mean values and the standard deviation of value added, capital and the number of employees for the four sectors.

INSERT TABLE 1 ABOUT HERE

5. Estimation results

For the estimation, the fitted values of a logit equation for formally registered firms, are entered in the equation[8]. This procedure is adopted to account for the possible bias originating from endogeneity of the variable FORMAL.

The results for the estimated frontier production function are presented in table 2. The first two columns present the basic frontier estimation, for the original and the extended sample respectively. The third and the fourth column show the estimation results of the firm specific inefficiency model for the respective samples.

INSERT TABLE 2 ABOUT HERE

Returns to scale can be calculated from the estimated frontier production function as the sum of the elasticities of the variables capital and labour. The joint estimates suggest increasing returns to scale for agro-industries, metal working and wood working. The sum of the elasticities are close to the range 1.40-1.50. A t-test indicates that the sum of the coefficients of capital and labour in these three sectors are significantly different from one. This result is robust when the estimation is repeated using different samples. In the textiles sector no significant returns to scale are found. Increasing returns to scale have important policy implications. Market expansion through regional market integration, trade liberalisation and diversification should be one of the major concerns of the authorities to allow firms to attain the scale of operations at which scale economies are fully exploited.

The parameters theta and var(v) are significant at the 1% level. The significance of the parameter theta, the parameter of the one sided error term capturing technical inefficiency effects, suggests that the effect of inefficiency is real and is not the result of random error. The estimated mean of u, given by $1/\theta$, equals 0.90 and 0.76 for the extended sample. The average technical efficiency, e^{-u}, equals 0.41 and 0.47 respectively. These results are comparable to efficiency levels observed in other developing countries. Comparable estimates with data of the RPED-project in other African countries show technical efficiency

[8] In instrumenting the variable FORMAL, variables for firm size, age, sector, foreign ownership, location and exporting activity were used as explanatory variables.

levels to average 33% in Ghana, 41% in Kenya and 52% in Zimbabwe (Biggs et. al., 1995). Pitt and Lee (1980) found the technical efficiency of firms in the Indonesian weaving industry to be substantially higher, ranging between 61.8 and 67.7%.

In the firm specific inefficiency model (columns 3 and 4), foreign ownership tends to shift the frontier production function upwards, which is consistent with former empirical evidence. The positive effect of foreign ownership is significant for European owned firms. The results hold when the estimation is done using the different samples.
In a similar way, formal firms tend to produce at a higher efficiency level than informal or semi-formal firms. This indicates that informal firms, which are deprived from the more scarce resources and forced to operate with only abundantly available production factors, are unable to reach the efficiency levels of formal firms which are in a better position to select an optimal combination of inputs. This also indicates that inputs are no perfect substitutes for each other.

The age of the firm does not seem to have any significant impact on the location of the production frontier. As mentioned earlier, the ageing effect of a firm tends to be positive for firm efficiency as firms learn over time, but at the same time, newer and younger firms enter with upgraded technology, partly offsetting the learning advantages of older firms in the cross section sample.

6. Firm efficiency and profitability

In well functioning markets efficiency translates into superior performance in terms of market share and profitability. Therefore, this section focuses on explaining firm profitability with respect to firm efficiency and analyses whether there are other factors besides efficiency which essentially determine firm profit margins.

Superior firm profitability can result from market structure characteristics which enable firms to raise prices above marginal cost levels. Industry concentration and the existence of barriers to entry may results in collusive behaviour of oligopolistic firms which allows them to realise supra-normal returns. Several empirical studies inspired by Bain (1956) found a significant positive correlation between profitability and concentration. Within the industry however, interfirm profitability differences may reflect differences in the competitive position of firms as can be measured by firm market shares. In homogeneous goods industries, higher profitability associated with larger market shares may reflect better cost efficiency of firms (Clarke, Davies, 1982)[9]. Extending the theory for heterogeneous goods

[9] In a generalised Cournot model for homogeneous goods, firm i's market share and profitability can be expressed by the following equations (Clarke, Davies, 1982) :

$$s_i = \frac{-\alpha}{1-\alpha} + \frac{\eta}{1-\alpha}\left(1 - \frac{c_i}{\bar{c}}\frac{((\eta-\alpha)-(1-\alpha))}{\eta}\right) \quad ; \qquad \frac{p-c_i}{p} = \frac{s_i(c_i) - \alpha s_i(c_i) + \alpha}{\eta}$$

industries, firm profitability is determined by market structure, and by the firm's efficiency and ability to differentiate products through advertising or R&D expenses (Sutton, 1991).

In markets which are characterised by severe imperfections and information asymmetries, firm performance may also be determined by the institutional environment. Following this line of reasoning, legitimation and reputation effects may become important factors for the establishment of a competitive position and for firm profitability, besides the process of competition which selects the most efficient firms into the industry. This implies that factors such as firm age and the formal status which can signal to the business environment that the firm is a reliable business partner and grants it legitimation in the eyes of clients, suppliers, and other contracting parties, may thereby increase the firm's market share.

For the empirical analysis, a structural model is estimated:

$$\Pi_i = f(s_i, X_i; \beta)$$
$$s_i = f(u_i, Y_i; \gamma)$$

where u_i is firm efficiency and s_i is the market share. X_i and Y_i are sectoral variables and variables of firm specific characteristics which capture legitimation of the firm. Beta and gamma are the corresponding parameters.

Data and variables

Profitability (PROFITS) is measured as the value of sales minus the sum of raw materials, labour costs and indirect costs[10], proportionate to the value of sales.
Firm efficiency is measured by the individual efficiency score, u_i, derived from the basic efficiency estimation done in previous section using the extended sample. Larger values of u_i imply more inefficiency within the firm. Hence, the expected sign for this variable is negative in both equations.

The effect of collusion, technological conditions and the existence of entry barriers on firms' market share and profitability are captured by the inclusion of the sectoral binary variables for the following sectors: textiles and clothing (SECTEXT), woodworking (SECWOOD), metal working (SECMETL), grain milling and flour confectionery (FLOUR), food processing and preserving (FOOD), manufacture of drinks and ice-cream (DRINKS), manufacture of oils and fats (OILS). The reference group of firms are active in the manufacture of sugar, tobacco products and other food products. The firm's market share is measured at the level of these subsectors. The inclusion of the sector dummy variables in both equations implies that firm market share and profitability are analysed as deviations from the sector mean.

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where $\bar{c}$ is the industry average marginal cost ($\bar{c} = \frac{\sum_{i=1}^{N} c_i}{N}$), α is the degree of collusion in the industry, η is the price elasticity of demand, and N the number of market participants.

[10] Indirect costs include rent, costs of electricity, water, fuel, telephone, transports, security, and advertising expenses.

Legitimation of the firm in the industry and reputation effects are measured by firm age and formal status. A variable LFIRMAGE measures the age of the firm in logarithmic terms. While reputation and patronage is built up over time, older firms may also be expected to have acquired a larger market share in an active or passive learning process by which they uncover and increase their efficiency level over time. To take further account of the firm's legitimation in the industry, a binary variable INFORMAL is included which equals one for informal and semi-formal firms.

Advertising intensity (AI) is measured by the firm's advertising expenses, relative to the value of sales. The variable DIFPRO equals one if the firm considers differentiation or superior quality of its main product as its major competitive advantage over competitors. The variable CAPINT proxies capital intensity of the individual firms using the logarithm of the cost of electricity, water, telephone and fuel, per employee.

Estimation and results

The results of a 2SLS estimation procedure are presented in table 3. The first column shows the market share equation while the second and third column show the profitability equation, where the market share as well as the formal status of the firm are instrumented variables.

INSERT TABLE 3 ABOUT HERE

The average market share of the firms in the sample equals 2.4%. The largest market shares are found in the manufacture of oils and fats, followed by the beverages sector, the smallest market shares being in metal working and textiles and clothing.

In line with the expectations, more efficient firms are rewarded with larger market shares. The variable INEFFIC, measuring firm inefficiency, has a negative and significant coefficient. More advertising intensive firms have also significantly larger market share. The results also support the view that a firm's competitive position in the industry is the result of reputation effects by which patronage is build up over the lifetime of the firm. Older firms have a significantly larger market shares. The formal status of the firm does not seem to have a significant impact on market shares.

The average profitability for the sample firms equals 0.27. However, significant sector effects seem to determine a firm's expected profitability. In the textiles sector, in metal working, wood working and grain milling and flour confectionery the profitability of firms tends to be significantly higher as compared to firms in the reference sector sugar, tobacco and other food products. Higher profitability within an industry might be due to collusion or to the existence of entry barriers which raise profitability of the incumbent firms. Besides these factors which operate at industry level, the firm's competitive position within the industry, as measured by the fitted value of the firm's market share, also has a significant impact on the profitability of the individual firm. The coefficient of the variable PREDMS indicates that a 10% increase in the market share leads to a 19.8% increase in profitability. More capital intensive firms have a significantly higher price cost margin, to generate a positive return to the higher levels of capital stock the firm has invested in. The variable DIFPRO, capturing the effect of product differentiation on profitability, has the right sign, but the effect is not significant.

Conclusion

This paper measures the level of technical efficiency of manufacturing firms in Côte d'Ivoire and analyses its effect on firm size and profitability.
It is clear from the estimated frontier production function that most sectors of activity exhibit large economies of scale. An increase in the scale of operations of firms would lead to a significant reduction in costs and to an increase in welfare. However, many firms that are hampered in their growth, are operating at a small scale such that scale economies remain largely unexploited.

Moreover, irrespective of the scale of activities, a large majority of firms is producing at much lower levels of output than the one which could be reached under efficient production using the same quantity of inputs. For the sample of firms used in the analysis, only 41% of the attainable output under efficient production is actually produced. These results compare fairly well with other studies conducted in other African countries where technical efficiency levels were found to range from 30-50% (Biggs et.al., 1995).

This is coupled with significant inter-firm efficiency differences. Firms which are inserted in international networks through European or Asian ownership linkages tend to produce at higher levels of technical efficiency. The same holds for formal firms, which have access to a larger range of production factors and can chose more easily the optimal combination of inputs.

As to the wider competitive effects, more efficient production and more advertising intensive marketing translate into a better competitive position and via its impact on the market share into higher profitability. However, besides the competitive market selection mechanism, other forces determine a firm's competitive position. Older firms tend to occupy a larger share of the market. While older firms are not found to be significantly more efficient, reputation and legitimation effects which become important when informational asymmetries characterise the market system, seem to operate in their favour.

Firm profitability is characterised by important sectoral variation which suggests that there exist substantial inter-industry differences in factors creating rents, including technology, collusive practices or barriers to entry.

The findings have important policy implications. First, in order for firms to reach higher levels of technical efficiency, access to a broad range of resources should be enabled. Efforts should be made to eliminate discriminatory measures and to facilitate transparency and transfer of information in markets, so that firms move closer to the maximum attainable output level and hence grow more smoothly into a larger size where scale economies can be exploited. Markets should grow. Further regional market integration and insertion of the manufacturing sector into regional networks may serve this purpose. Second, the market selection should be improved so as to provide firms with the necessary stimulus to increase efficiency and avoid X-inefficiency.

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Appendix:

The loglikelihood function for the basic model, without firm specific inefficiency explanatory variables, takes the form:

$$\ln L = n\ln\theta + \frac{n\theta^2\sigma_v^2}{2} + \theta\sum_{i=1}^{n}\varepsilon_i + \sum_{i=1}^{n}\ln F\left[\theta\sigma_v - \frac{\varepsilon_i}{\sigma_v}\right]$$

Where F is the cumulative distribution function,

$$\lambda = \frac{\sigma_u}{\sigma_v},$$

$\sigma^2 = \sigma_v^2 + \sigma_u^2$ and

$\varepsilon_i = v_i - u_i = \ln Y - \ln A - \sum_{j=1}^{n-1}\partial_j D_{ij} - \sum_{j=1}^{n}\alpha_j D_{ij}\ln K_i - \sum_{j=1}^{n}\beta_j D_{ij} L_i$ for the chosen Cobb-Douglas functional form. Following Reifschneider and Stevenson (1991), firm specific inefficiency is estimated assuming the inefficiency disturbance term u to be composed of two factors, a factor reflecting systematic influences and one random factor:

$u_i = g(Z_i) + w_i$

where Z^i is a vector of firm specific explanatory variables and w_i is the unexplained component of inefficiency. The loglikelihood function can be derived from the basic frontier model, by replacing ε_i by $\varepsilon_i^{'}$ where, following the chosen functional form of the production function,

$$\varepsilon_i^{'} = v_i - w_i = \ln Y_i - \ln A - \sum_{j=1}^{n-1}\partial_j D_{ij} - \sum_{j=1}^{n}\alpha_j D_{ij}\ln K_i - \sum_{j=1}^{n}\beta_j D_{ij} L_i + \sum_{k=1}^{m}\gamma Z_{ik}$$

Table 1.: Summary statistics, per sector

Original sample	N	Value added	Number employees	Capital
Agro-industries	28	1333.6	117.6	1078.7
		(2683.6)	(183.8)	(3464.3)
Textiles	18	293.3	74.9	190.7
		(1154.2)	(259.5)	(760.1)
Wood working	25	1296.5	142.2	216.6
		(2794.1)	(271.8)	(443.9)
Metal working	21	17084.6	60.2	503.3
		(76646.3)	(81.8)	(1734.2)
Extended sample	**N**	**Value added**	**Number employees**	**Capital**
Agro-industries	47	2356.6	233.8	795.4
		(5623.9)	(710.9)	(2739.7)
Textiles	41	555.3	114.1	171.1
		(1706.2)	(314.4)	(585.6)
Wood working	45	4539.1	135.1	204.2
		(22201.2)	(232.1)	(378.9)
Metal working	42	8802.8	64.4	291.0
		(54189.3)	(82.0)	(1232.9)

Note: Value added (V.A.), and capital are expressed in millions of F.CFA.

Table 2. Estimation results of the frontier production function

	basic model		firm specific	ineff.model
Constant	6.239	5.075	8.696	6.899
	(4.889)	(3.006)	(3.976)	(2.779)
SECFOOD	3.763	5.077	1.660	3.187
	(5.481)	(3.799)	(4.351)	(3.411)
SECFOOD*CAP	0.275	0.295	0.245	0.265
	(0.151)	(0.164)	(0.114)	(0.139)
SECFOOD*LAB	1.235	1.095	1.027	0.973
	(0.324)	(0.214)	(0.323)	(0.210)
SECTEXT*CAP	0.610	0.691	0.412	0.538
	(0.462)	(0.270)	(0.365)	(0.246)
SECTEXT*LAB	0.398	0.434	0.438	0.436
	(0.720)	(0.409)	(0.567)	(0.364)
SECWOOD	-1.755	-1.488	-2.942	-2.356
	(5.290)	(3.306)	(4.225)	(2.976)
SECWOOD*CAP	0.711	0.759	0.608	0.674
	(0.115)	(0.105)	(0.130)	(0.105)
SECWOOD*LAB	0.672	0.719	0.535	0.574
	(0.165)	(0.161)	(0.209)	(0.181)
SECMETL	-3.745	-2.139	-5.560	-2.292
	(5.696)	(3.714)	(4.752)	(3.485)
SECMETL*CAP	0.841	0.808	0.800	0.649
	(0.247)	(0.178)	(0.244)	(0.177)
SECMETL*LAB	0.648	0.666	0.353	0.634
	(0.465)	(0.327)	(0.463)	(0.343)
EUROPEAN			0.911	0.791
			(0.446)	(0.332)
ASIAN			0.479	0.411
			(0.509)	(0.410)
AGE			0.009	0.163
			(0.456)	(0.284)
FORMAL			0.665	0.761
			(0.676)	(0.458)
θ	1.113	1.307	1.093	1.360
	(0.311)	(0.268)	(0.299)	(0.279)
VAR(σ)	0.956	1.09	0.868	1.042
	(0.177)	(0.104)	(0.172)	(0.096)
N. observations	92	175	92	175
Log-Likelihood	-152.87	-296.72	-146.62	-285.03

Note: Standard errors are in parentheses.

Table 3. Determinants of market share and the price cost margin

Dependent variable:	Market share	Dependent variable:	Profitability
constant	0.020	constant	0.068
	(0.021)		(0.077)
INEFFIC	-0.008	PREDMS	1.984
	(0.005)		(0.940)
AI	1.187	DIFRPO	0.058
	(0.662)		(0.060)
LFIRMAGE	0.019	LCAPINT	0.045
	(0.005)		(0.023)
INFORMAL	0.001	INFORMAL	-0.084
	(0.008)		(0.075)
FLOUR	-0.040	FLOUR	0.207
	(0.029)		(0.074)
FOOD	-0.047	FOOD	0.125
	(0.033)		(0.098)
DRINKS	0.038	DRINKS	0.029
	(0.088)		(0.087)
OILS	0.058	OILS	-0.099
	(0.066)		(0.180)
SECTEXT	-0.049	SECTEXT	0.270
	(0.024)		(0.072)
SECWOOD	-0.034	SECWOOD	0.205
	(0.023)		(0.067)
SECMETL	-0.050	SECMETL	0.283
	(0.023)		(0.078)
R^2	0.2570		0.1547
N observations	165		165

Note: Standard errors (in parentheses) are estimated using White's consistent estimator (White, 1980)